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Life cycle assessment and additives: state of knowledge

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1. Introduction

Concerns about possible effects on human health and the environment from additives/impurities accumulated in globally recycled waste/resources like paper and plastics was one of the main reasons for starting up the EU FP7 Coordination Action project RiskCycle (www.wadef.com/projects/riskcycle). A key aim of the project is to identify research needs within this area focusing on both risk assessment (RA) and life cycle assessment (LCA). Besides the sectors on paper and plastics (being the focus here) also lubricants, textiles, electronics and leather are included in RiskCycle. In Figure 1 the life cycle of printed matter (paper) is illustrated showing the recycling step which is in special focus in RiskCycle.

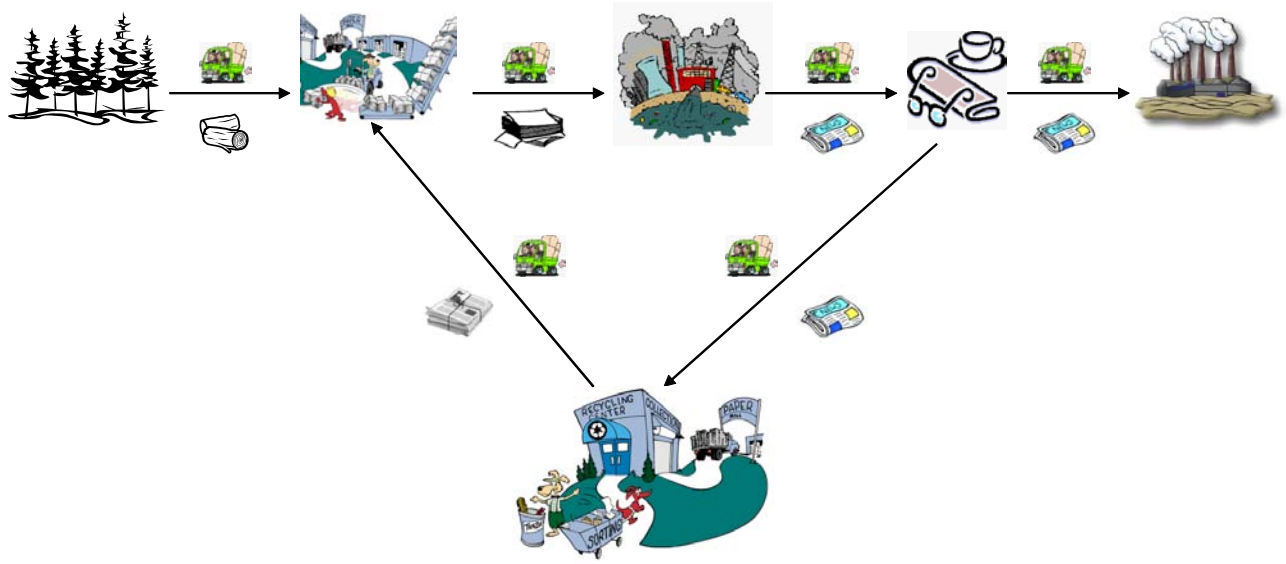

Figure 1: Life cycle of printed matter including recycling [1].

2. Results

On plastics a literature review regarding the state of knowledge on additives/impurities in LCA has been performed within RiskCycle [2]. Several inventory databases (LCI data) have been investigated and the result shows that most LCI databases use PlasticsEurope data for plastics production. Most of these data are aggregated and do not include additives, although this is not obvious. Furthermore, there is no data on use and recycling, and data on incineration are not specific for additives. Regarding the production of additives only data on metals and DEHP was identified. As regards LCAs on plastics 110 papers has been reviewed. Only 25 of these mention additives but they are not included in the emissions list. Many of the studies are on waste management and additives may be mentioned as problem for recycling, but no numbers. Only a few studies include additives in the impact assessment and additives are never mentioned as important for the outcome. A way to approach the lack of inventory data may be to use Material Flow Analysis and emission factors as in a recent Swedish study on emissions of additives from plastic materials [3].

Regarding LCAs on printed matter (including paper) only a few studies has been done – mostly focusing on the energy part [4;5]. However, one of the most recent and comprehensive studies [4;5] actually include toxic impacts from chemical emissions – mostly printing chemicals like printing ink of which some components

may accumulate in recycled paper. Even though recycling is included in this study there is no special focus on the additives/impurities in the recycled paper. Anyway, the study shows that potential toxic impacts from the production and use of chemicals like pigments, solvents, metals, AOX and biocides may play a very significant role in the impact profile of printed matter. However, the study only considered a few generic chemical recipes (one printing ink, few cleaning agents etc.) and at least the following shortcomings in need of further research may be identified:

- Ink components (and their precursors) production: siccatives, antioxidants, pigments, dyes etc.
- Water emissions from paper production: softeners (BPA), other phenolic compounds (NPE, APE), other surfactants (LAS), biocides (benzothiazoler, dibromo-compounds), wood extractions (terpenoids, resin acids) and more
- Recycling of paper: Fate of paper chemicals, ink chemicals, glue chemicals etc.
- Treatment of chemical waste: Fate of (hazardous) waste from printing (ink waste, used cleaning agents, used rinsing water etc.) and from recycling of paper (sludge from repulping)

Regarding the life cycle impact assessment (LCIA) part an investigation of the availability of characterisation factors (aquatic ecotox) for the about 17 additives/impurities to be included in RiskCycle have been done. These additives belong to 15 chemical groups/chemicals: PFOS, PFOA, NPAA, HBCDD, triclosan, DEHP, lead, organotins, pentabromodiphenylethers, decabromodiphenylether, TPP, mercury, NPE, BPA and biocides. The best practice LCIA "consensus" model USEtox [6] was chosen. For only nine of the 17 substances characterisation factors exists and four of these are preliminary (interim). Regarding the rest, factors have to be calculated - if possible.

3. Conclusion and discussion

Based on the results obtained until now within RiskCycle it may be concluded that in order to perform LCAs on waste/resources recycled globally both new inventory data and new characterisation factors have to be provided. A preliminary solution to the lack of inventory data may be to use Material Flow Analysis and emission factors. One of the main reasons for this lack of useable data on additives for LCA is probably the general focus on energy which has dominated LCA until recently. Impact categories related to toxicity (and chemicals) are more difficult to handle. Anyway, consensus on how to deal with human toxicity and ecotoxicity in LCIA is approaching and the USEtox model is probably the best candidate.

4. References

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